



Recent Advances in Heterocyclic Chemistry Seminar at NCL

A seminar on 'Recent advances in heterocyclic chemistry' was held at the National Chemical Laboratory (NCL), Poona on 7 and 8 September 1970. Fourteen papers were presented and discussed in four technical sessions. One session was devoted to the physical organic chemistry of heterocyclic compounds and the remaining three sessions were devoted to the synthetic aspects of heterocyclic chemistry. Some sixty scientists from university departments, research institutions and industrial research establishments participated in the seminar.

Physical organic chemistry of heterocyclic compounds

In this talk, C. N. R. Rao of the Indian Institute of Technology (IIT), Kanpur reviewed briefly the theory of electron donor-acceptor interactions. Various aspects of experimental studies with respect to heteroaromatic systems such as pyridine as donor with special emphasis on electronic spectroscopy were dealt with. The pi-electronic structure of thiophene, substituted thiophenes and dibenzothiophene was discussed by P. T. Narasimhan, also of IIT, Kanpur. During the course of his talk, he presented electronic structure of thiophene, substituted thiophenes and dibenzothiophene. He also discussed the results of his calculations on the spin density distribution in the radical anions of nitrothiophenes and dibenzothiophenes for both *p*- and *d*-orbital models.

V. N. Gogte (NCL, Poona) elucidated the structure of various heteroaromatic compounds such as condensed thiophenes, furans, benzophenanthridines and benzoacridines. He dealt with the various parameters in deciding the site of cyclodehydration reactions. During

the presentation of his paper, P. M. Nair (NCL, Poona) discussed the NMR spectra of a number of condensed thiophenes and attempted to analyse the chemical shifts in terms of steric effects, ring currents and pi-electron charge densities.

Synthetic aspects of heterocyclic chemistry

Harkishan Singh of the Panjab University, Chandigarh discussed some prominent features of drug design in heterosteroids and some aspects of their syntheses. He also gave an account of the syntheses of various new heterosteroid systems. S. V. Kessar, also of the Panjab University, defined transcyclization and discussed the kinetic requirement of its mechanistic categories. He described a reaction wherein transcyclization was brought about by addition or expulsion of amide ion across a double bond and by the generation of aryne type intermediates.

T. R. Kasturi of the Indian Institute of Science, Bangalore dealt with the keteminization of nitrile groups in 1,2-dicyano esters and 1,1,2-tricyano esters on the basis of ultraviolet spectra. To prove this keteminization, addition of water to these compounds was carried out by him, resulting in the facile formation of pyridine derivative. Likewise addition of alcohol to the aforementioned alkylidene malononitriles resulted in ethoxy pyridine derivatives, the structure of which was discussed. Nitya Anand of the Central Drug Research Institute, Lucknow outlined the synthesis of 2, 3-diphenylbenzofurans from benzoin and benzoyl *o*-methoxydiphenylmethanes and that of the three of the four possible diastereoisomers of 3, 4, 5-triphenyltetrahydrofuran-2-one and tetrahydrofurans from

methyl threo and erythro-3-benzoyl-2, 3-diphenyl propionates. A facile one-stage synthesis of 1, 2, 4-triazines was presented by V. R. Srinivasan of the Osmania University, Hyderabad. During his talk, he presented the spectral and analytical data for the structures of 3, 6-disubstituted triazine derivative and elucidated the synthesis of a variety of compounds.

M. V. George (IIT, Kanpur) dealt with thermal/photochemical transformation of Sydnone and related systems. At IIT, Kanpur, George and his group have found that Sydnone undergo photochemical cycloaddition with different dipolarophiles giving rise to products which are different from thermal addition products. He also referred to some details of the available information concerning the photolysis of tetrazoles, azalactones, triazoles and related systems. M. D. Nair of CIBA Research Centre, Bombay discussed the reactions of acetylenic esters with bifunctional nucleophilic reagents. He emphasized the reactions leading to heterocyclic and condensed heterocyclic ring systems. He also discussed the scope and limitations of this synthetic route to heterocyclics. Nagbhusan Rao of the Regional Research Laboratory, Hyderabad outlined the synthesis of three dithiaindanones and the behaviour of these ketones towards reduction and dehydration reactions.

Miss H. V. Berde (NCL, Poona) gave an account of the synthesis of nitrogen containing heterocyclic compounds through rearrangement reaction starting from cis-2-arylaminoethylenealkanone by means of various acid catalysts. She discussed the probable mechanisms of these cyclodehydration and rearrangement reactions. K. G. Das (NCL, Poona) spoke on bond formation under electron impact and elucidated how this phenomenon provides information on ion structures and fragmentation mechanism.

Upgrading of Small Coal from Bistrampur Colliery

The present production of Bistrampur colliery of the National Coal Development Corporation (NCDC) is about 9 lakh tonnes per year which is expected to reach 1.85 million tonnes in the near future. The run of mine coal is size separated into three fractions: 25 mm, 25-6 mm, and -6 mm. While the first two fractions are directly consumed in locomotives and power generation, the smalls fraction (present production, 1 lakh tonnes) finds no outlet because of its high ash content (20-25%). The disposal of this fraction poses a serious problem in addition to considerable loss of combustible matter. On a request from NCDC, the Central Fuel Research Institute (CFRI), Dhanbad undertook investigations on the upgrading of coal fines (below 6 mm) of the Bistrampur colliery.

The institute carried out screening and float and sink tests and explored the applicability of various techniques for the upgrading of the fines including (i) selective and wet screening, (ii) separation in hydrocyclone and concentrating table, and (iii) dewatering of products by drainage, filtration and oleoflotation process.

The results of laboratory screening and float and sink tests have revealed that the associated dirt is of extraneous nature which is concentrated in the fraction below 1 mm. The problem of upgrading these fines is therefore mainly a problem of size separation.

The tests point to the conclusion that the most attractive solution is the wet screening of the small coal in sieve-bend at about 1 mm, followed by vibrating screen, and beneficiation of the slurry below 1 mm (where necessary) by hydrocyclone. By this simple process of upgrading, about 85-90% of the raw coal can be recovered with an ash content of about 17% from a level of about 22%.

The adhered moisture content of the sieve-bend and dewatering screen overflow (plus 1 mm) was about 20%, but there is scope for reducing the moisture by using a high frequency vibrating screen. Experiments in a 150 mm diam drainage column showed that the surface

moisture could be brought down to about 8% in about 5-6 hr.

Filtration of the upgraded slurry (-1 mm) is beset with difficulties. Instead, provision for a number of settling tanks for receiving, setting and sun-drying of the slurry reclaiming appears to be attractive.

PROGRESS REPORTS

NCL Annual Report: 1969-70

The Annual Report of the National Chemical Laboratory (NCL), Poona for the year 1969-70, which has been published recently, reviews the progress of work, as in the previous years, under the four sections: Sponsored projects (projects sponsored by industry, government departments, etc.); Pilot plant projects; Product oriented research; and Research projects. Eleven sponsored projects were successfully completed and eight were in progress. Product oriented projects numbered 80 and their breakup into various areas of research were as follows: solid state materials—6; inorganic and organic metallic products—9; natural and synthetic organic chemicals—41; rubber and polymeric materials—18; and instruments—6.

One of the projects investigated under the sponsorship of private parties was concerned with the development of perfumery chemicals based on longifolene and isolongifolene. Indian turpentine oil obtained from *Pinus longifolia* contains 2-10% longifolene which has no utility. Longifolene was converted into some derivatives having perfumery value; the details were furnished to the sponsor. The laboratory also worked out process details for producing a perfumery product on 1 kg scale from isolongifolene obtained as a byproduct in certain reactions of isolongifolene.

A modification of the process worked out during the previous year for the manufacture of carbimazole (a drug used in the treatment of hyperthyroidism and angina pectoris) was investigated, and of the four steps involved two were standardized. Experiments on vapour phase oxidation of anhydrous titanium tetrachloride at 1200°-1700°C were successfully carried out and the formation of rutile phase and its

However, on mixing the partially watered 6-1 mm small coal and -1 mm cleaned slurry cake with the raw 25-6 mm size coal, it is expected that the free moisture content of the combined product would hardly exceed 6-7%, which should be acceptable to power plants.

correlation to the quenching temperature and retention time in the reactor were studied. A liquid barium-cadmium stabilizer for PVC using indigenously available chemicals was developed on a laboratory scale. Conditions for the preparation of butylated hydroxyanisole, an anti-oxidant additive used in fuel and lubricating oils, were standardized on a laboratory scale.

A new project sponsored by the Hindustan Organic Chemicals (HOC) Ltd, Rasayani in continuation of NCL's work on the manufacture of chlorobenzenes was concerned with the development of a continuous process yielding monochlorobenzene as the predominant product. The earlier pilot plant of 10 kg/hr capacity was suitably modified and conditions were standardized for the desired product composition. Earlier, a turn-key project for the manufacture of chlorobenzenes (4400 tonnes/annum; monochlorobenzene 3500 tonnes, *o*-dichlorobenzene 300 tonnes and *p*-dichlorobenzene 600 tonnes) was offered to HOC by a firm on the basis of developmental work carried out at NCL followed by investigations on a semi-commercial plant by the firm.

Under a multi-purpose pilot plant project the laboratory has been investigating the scale-up of batch scale processes for the manufacture of organic intermediates. *o*-Tolylbiguanide was prepared on 50 kg/batch scale and the process was licenced to a firm. Tris-nonyl phenyl phosphite was prepared on 150 kg/batch scale. Pilot plant trials for the production of *o*-nitrophenol, *p*-nitrophenol, *o*-aminophenol, catechol and *p*-tert-butyl catechol were carried out, and negotiations were in progress for releasing these processes to industry.

One of the product oriented research projects was concerned with the development of hard as

well as soft ferrite compositions. A nickel-zinc-cobalt soft ferrite composition containing less nickel than the conventional products, suitable for antenna rods, was developed.

The preparation and properties of acicular γ -ferric oxide, which is particularly suitable for coating magnetic recording tapes, were investigated. The laboratory had earlier developed a process for preparing γ -ferric oxide through controlled decomposition of ferrous oxalate. Another process for its manufacture was developed during the year. In this process scrap iron is converted into hydrated ferric oxide which is first reduced to magnetite and oxidized to γ -ferric oxide. The magnetic properties of the product were found to be within the range required for materials used for coating magnetic recording tapes. Magnetic materials used for coating recording tapes are presently imported to the extent of 6.5 tonnes/annum valued at about Rs 1 lakh and the demand is likely to increase to 30 tonnes/annum with the growth of the recording tape industry.

The preparation of semi-conductor grade silicon through thermal decomposition of silane was investigated. This method unlike the other two methods, viz. cracking of silicon tetraiodide and hydrogen reduction of trichlorosilane, gives a product better in purity and higher in overall yield. Two runs on 25 g scale were successfully completed with 95% of the theoretical yield.

Processes for the following chemicals were worked out : (1) N, N-diethyl-*m*-toluamide, an effective mosquito repellent (laboratory scale); (2) terpin hydrate from α -pinene and terpineol from terpin hydrate (1 kg/batch); (3) single step direct reduction of camphene to camphor (laboratory scale); and (4) *p*-menthane hydroperoxide. Conditions for obtaining chromatographic grade cellulose powder (300 mesh) from cotton and groundnut shell pulp in good yield on 1 kg/batch scale were standardized. The laboratory scale process developed earlier for the production of triphenyl phosphate, an important plasticizer used in photographic films, was scaled up to 5 kg/batch.

The process for the manufacture of simazine, a herbicide used for controlling herbs associated with wheat, maize and other crops, worked out on 0.5 kg/batch scale, was scaled up to 3 kg/batch. Field trials on the use of the compound showed satisfactory results. A process for the preparation of pure phenylacetic acid suitable for the manufacture of penicillin G was standardized on 1 kg scale starting from indigenously available benzyl chloride.

Among the instruments and devices designed and fabricated by NCL mention may be made of (i) a working model infrared spectrophotometer (2 units); (ii) electron diffraction camera (3 units); and (iii) self-balancing strip chart recorder.

The impact of the technology developed by NCL on the chemical industry is noteworthy. For example, the acetanilide plant of the Hindustan Organic Chemicals Ltd,

based on NCL know-how, has been running to full capacity. Alta Laboratories, Khopoli commenced production of di-octyl phthalate based on NCL know-how and the production during 1969-70 was 197 tonnes valued at Rs 14.6 lakhs. The calcium hypophosphite plant of Hypophosphite & Co, Bombay, also based on the work of NCL, went into operation.

A new feature of the report is the cost-benefit analysis made for the first time. As against the total inputs of Rs 71.57 lakhs, direct benefits amounted to Rs 10.41 lakhs. The ratio of receipts to recurring expenditure rose from 16.6 in 1968-69 to 18.9 in 1969-70. Also included in the annual report is a brief review of progress during the last 20 years (1950-70) in which an overall cost-benefit analysis of the work of the laboratory during the 20-year period since the inception of the laboratory has been made.

Livestock (including Poultry)

Supplement to the Wealth of India : Vol. VI

This volume, issued as a supplement to Vol. VI (L-M) of the Wealth of India : Raw Materials series, has been brought out recently by the Publications & Information Directorate, New Delhi. The volume deals with all aspects of the livestock wealth of the country, including poultry, under one cover. The main sections of this supplement include Cattle and Buffaloes, Sheep, Goats, Pigs, Horses and Ponies, Donkeys and Mules, Camels, Yaks, Chemistry of Livestock Products, Marketing and Trade, and Poultry.

In each section upto date scientific information on breeds and breeding, feeds and feeding, management, diseases and control, products and their economic uses, etc. are dealt with. Statistical data, mostly based on the Livestock Census 1961 wherever available, are given.

In the section on Chemistry of Livestock Products, properties, composition, preservation and processing, and nutritive value of milk and milk products, meat and meat

products and byproducts of milk and meat industry are given in detail.

The section on Marketing and Trade deals with the marketing practices of livestock and their products, export and import data for the period 1963-64 to 1967-68, and prices of some important products.

Poultry, being an important industry by itself, has been treated separately at the end. This section includes besides description of the breeds, brief accounts on feeds and feeding, poultry diseases, poultry products and their utilization, and marketing and trade.

A selected bibliography, arranged sectionwise, and a comprehensive index giving the names of breeds, diseases and products are useful additions in this supplement.

This well illustrated volume, as in the case of earlier volumes in the series, will be useful to specialists as well as laymen interested in the particular field of study.

Sea Water : A Supplemental Source of Irrigation CSMCRI's Investigations

Nearly 36% of the gross land area of the world lies in the arid to semi-arid region where the rainfall is too scanty and erratic to support plant growth. In such regions the water available is brackish or saline and hence the plant growth is restricted to some drought or salt-tolerant species and the scarcity of proper irrigation water necessitates the use of saline water source for agricultural purposes.

Recently many countries have investigated the possibilities of bringing under cultivation the sand dunes with saline water including sea-water. In Israel a part of the desert was converted within a span of ten years into an ever-green garden with trees, shrubs and ornamental plants using underground water having 2000 mg/l salt. Later, more than 200 species of plants were introduced by irrigating with water from the Mediterranean Sea having a salinity range from 10 000 mg/l to oceanic concentration. On experimental basis, vegetables, forage crops and plants of industrial use were successfully grown by irrigating with Caspian sea-water. In Sweden grasses and legumes were grown by irrigating with sea-water from the Baltic Sea (6 g/l). It was found that on clayey soils the yield decreased to 55%, while on sandy soils over 60% increase was observed. The water from the North Sea containing 32 g/l of salt resulted in the luxuriant growth of *Agropyrum junceum* in West Germany. A survey of coastal water of the eastern sea board in USA revealed that seasonal fluctuations in salinity levels from any level up to 35 000 ppm and when such water was applied by sprinkler irrigation to lettuce on sandy loam, no damaging effect was observed. At the Marine Agricultural Station in Spain attempts were made to grow many food, forage and vegetable crops by direct irrigation of sea-water. Large scale cotton cultivation with saline ground water on coastal regions has been achieved in USSR.

India has great potentialities for harnessing the enormous reserve water of sea and vast coastal sandy

belts estimated at 8.5 million hectares along the 5600 km coastline. The Central Salt & Marine Chemicals Research Institute (CSMCRI), Bhavnagar has undertaken since 1963 evaluation of sea-water tolerance of crop plants which can be cultivated on coastal sandy belt taking advantage of regional rainfall and low sea-water salinity.

Laboratory experiments were conducted with many varieties of cereals, pulses, oilseeds, millets and forage crops to screen at germination and early seedling stage using sea-water of different salinity grades. Among the various crop seeds studied, bajra (Babapuri), sesamum (TMV1), groundnut (Punjab1), linseed (RR9), mustard (local), safflower (NP30), wheat (Karchia and Kata) and alfalfa (local) were highly tolerant to sea-water during the germination stage. Very low dilutions of sea-water stimulated the plumule and radicle growth, but 10 000 ppm sea-water or above reduced it more or less in proportion to the increase in the salt content of the media. Solution uptake by the seeds was inversely proportional to the total salts present in sea-water dilutions and the superimposed specific ionic effects over osmotic effects were seen in higher concentration with reduced germination.

Metabolic studies conducted with seedlings of wheat, barley and Bengal gram under controlled conditions revealed that the amendment of sea-water dilutions with Hoagland's nutrients overcomes considerably the depression of general metabolic rate. Respiratory activity was reduced by sea-water application, and amendment with nutrient salts stimulated the endogenous respiration in root portions. The phosphorus metabolism of wheat, Bengal gram, safflower and bajra seedlings under saline conditions was investigated with radioactive phosphorus (^{32}P) and it was observed that salinity did not inhibit completely the uptake of phosphorus, but translocation and incorporation of absorbed phosphorus from inorganic to organic compounds was reduced. Using radioactive chlorine

(^{36}Cl) it was found that the antagonistic effects were produced by the added salts, specially calcium nitrate and potassium dihydrogen orthophosphate, in seedlings grown with sea-water dilutions. Protein synthesis was affected by sea-water treatment by an increase in the soluble protein nitrogen. The monocot and dicot responded differently to salinity treatments.

The sea-water tolerant varieties of wheat, barley, bajra and safflower seeds evaluated at germination stage were further tested in pot cultures with a view to assessing the limit of sea-water tolerance at vegetative and reproductive phases of growth and also yield characters. The acclimatization of crops with gradual increase in sea-water salinity was made for a period of three to four years with sea-water dilutions and amendments with various nutritive salts. Bajra (Babapuri), which was not sea-water tolerant earlier, was acclimatized to direct irrigation with sea-water within a period of four years. Such irrigation does not affect the vegetative growth of bajra much, but the yield decreases. For crops like wheat, barley and safflower the maximum limit of sea-water tolerance was only 20 000 ppm of sea-water even after acclimatization. Though the universal effect of salinity, namely, reduction in growth and yield, was reflected in all the crops studied, the quality of grains as judged from the main constituents such as carbohydrates, protein and fat was not affected by sea-water irrigation. The salt accumulation in the root zone of the plants was negligible even after direct irrigation with sea-water.

To determine the exact fertilizer requirement of crops under field conditions, sand bed cultivation of acclimatized seeds of wheat (Karchia and NP824), safflower (NP-30) and bajra (Babapuri) was carried out following the pot culture experiments. Water soluble and commercially available fertilizers were applied at required dose. In general the crops responded well to sea-water irrigation from 40 days onwards to maturity. The vegetative growth of plants was quite satisfactory and salinity effects were not exhibited by plants. The grain yield was reduced to 30-40% as



Growth response of wheat (top left), safflower (bottom left) and bajra (right) to irrigation with sea-water or sea-water dilutions

compared with the yield obtained employing fresh water irrigation. There was heavy accumulation of minerals in leaves, stem and roots, but retranslocation of salts to seeds was insignificant. Field experiments with acclimatized seeds of bajra are in progress for studying the effect of sea-water irrigation on growth and yield under natural conditions.

For carrying out field studies two field experimental stations are being established, one at Hathab near Bhavnagar and the other at Pondicherry.

The investigations carried out so far indicate the possibilities of growing acclimatized seeds of highly tolerant varieties of crops on sandy belt by sowing in the rainy season; the growth of the plants can be accelerated by fertilizing them initially and during non-rainy season, sea-water can be effectively utilized for irrigation purposes along with necessary nutrients to complete the growth of the plants.

The studies were carried out by Dr Thomas Kurian and Dr E.R.R. Iyengar under the supervision of Dr D.S. Datar, the Director.

Single Step Electrolytic Preparation of Perchlorates from Sodium Chloride

Potassium perchlorate is used as an oxidizer in fuels for military rockets, in explosives, in fire works and in flares. Ammonium perchlorate is required as an oxidizer in propellants for large thrust solid fuel boosters for missiles.

The methods at present in vogue for the electrolytic preparation of perchlorates involve two stages, namely the oxidation of chloride to chlorate and then of chlorate to perchlorate. Sodium chlorate and potassium chlorate are manufactured using graphite or magnetite anodes. In this process there is a loss of the anode during manufacture of the order of 20 to 40 kg of graphite per

tonne of chlorate produced. Magnetite anode is also attacked to a lesser extent but these anodes are used by a limited number of manufacturers.

For the manufacture of perchlorates from chlorate, sodium chlorate is the starting material and anodes of platinum and lead dioxide are employed in the process. When platinum anodes are used, the loss of platinum is of the order of 6 to 8 g/tonne of perchlorate produced. Lead dioxide anodes are made in several ways; the massive ones and the ones on titanium and tantalum substrates are also used for the process. The use of graphite substrate lead dioxide anode has been made possible by the work of the Central Electrochemical Research Institute (CECRI), Karaikudi. In all these cases where lead dioxide anodes are used it has been found necessary to add 2 g/l of sodium fluoride as addition agent.

The use of graphite substrate lead dioxide anode for the manufacture of sodium chlorate invented

by CECRI has shown that the process can lead to savings of at least four replacements of graphite anodes normally employed. In this process iron cathodes are employed with dichromate addition; use of stainless steel cathode was found to have some advantages, but the addition of dichromate inhibits the anodic oxidation of chlorates to perchlorates.

The institute has developed a process for the preparation of sodium perchlorate directly from a saturated solution of sodium chloride in a single step, using graphite substrate lead dioxide anode and stainless steel cathode followed by double decomposition of sodium perchlorate with either potassium chloride or ammonium chloride to get potassium perchlorate or ammonium perchlorate respectively. The conditions of electrolysis are as follows: Anode current density, 15-25 amp/dm²; temperature, 40-45°C; cell voltage, 3.9-4.5V; interelectrode distance, 1.5-2.0 cm; current efficiency, 55-60%; and energy consumption, 12.5-13.2 kWh/kg of NaClO₄.

The process has been successfully worked out by the institute employing an 800 ampere cell (capable of producing 5 kg NaClO₄/day) with graphite substrate lead dioxide anode and stainless steel cathode. Recently, one 400 ampere cell with six numbers of graphite substrate lead dioxide anodes (7.5 cm diam × 30 cm long) has been run and the anodes lasted 450 days of electrolysis. More than 3800 kiloampere-hours were passed

producing sodium perchlorate equivalent for the supply of about one tonne of potassium perchlorate.

The process is new as it has not been adopted and practised anywhere else in the world. None of the commonly used anodes, viz. graphite, magnetite or platinum, can be successfully employed singly as anode material for direct oxidation of chloride to perchlorate and lead dioxide anode is the natural choice at present. In view of this, the present invention can be regarded as original and novel.

The addition of sodium fluoride right at the beginning of the electrolysis to the sodium chloride solution makes a profound effect on the course of the electrolysis by increasing the current efficiency of the process.

In the conventional two-stage process, the dichromate which is added in the first stage for converting chloride to chlorate, has to be completely eliminated before the electrolyte is used for the second stage of conversion of chlorate to perchlorate using lead dioxide anode. However, in the process invented this does not arise as the electrolyte is free from dichromate right from the beginning.

The difficulties experienced in the current practice for removal of graphite sludge or ferric hydroxide and then isolating the sodium chlorate by separating the unconverted sodium chloride have all been obviated in the new process. Even if lead dioxide anode is employed for

the chlorate process, isolation and removal of dichromate cannot be avoided.

The advantages of this invention are : (1) Sodium perchlorate which is the starting material for other perchlorates like potassium and ammonium perchlorates is prepared directly from the cheap sodium chloride without intermediate processing and isolation of sodium chlorate. (2) Use of lead dioxide anode eliminates the consumption of either graphite or magnetite or platinum during the two-stage production of sodium perchlorate. (3) The addition of a small quantity of sodium fluoride at the beginning of the electrolysis increases the current efficiency of the process.

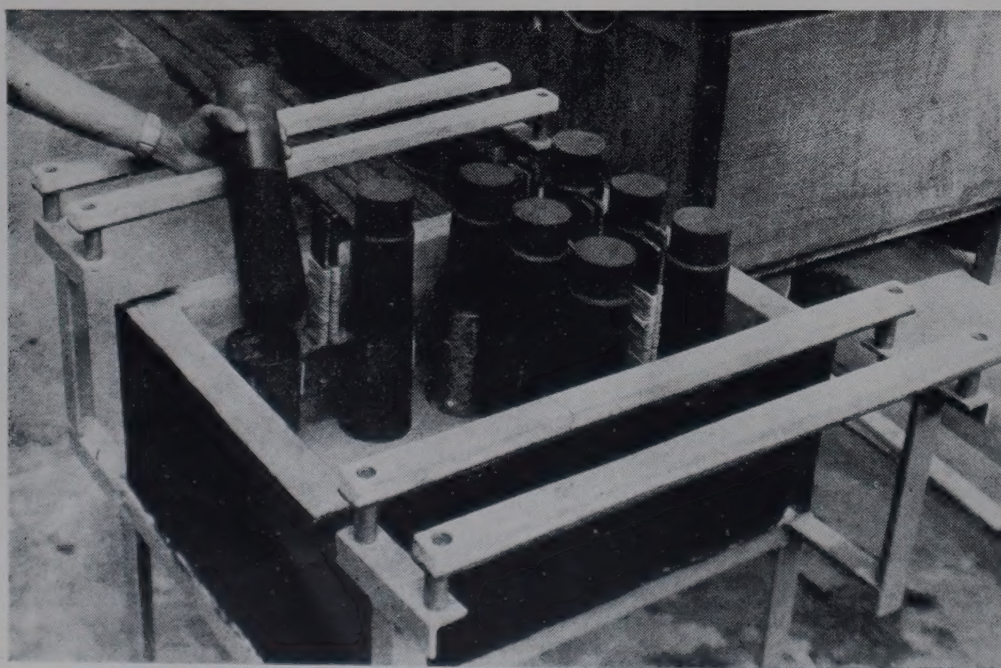
The cells used in this process can also be employed for the production of chlorates in case there is a slackness in the demand for perchlorates.

Potassium perchlorate and ammonium perchlorate prepared from the sodium perchlorate solution obtained from the present invention conformed to the stringent specifications of Defence and of the Space Science and Technology Centre respectively.

The present demand of the country, particularly for Defence and the Space Science and Technology Centre, is being met from the pilot production unit established at the institute for both potassium and ammonium perchlorates. The requirement of ammonium perchlorate for space research will be of the order of 360 tonnes within the next two years after which there would be a steady requirement of about 100 tonnes per year, whereas for explosives the requirement will be of the order of 500 to 600 tonnes/year. Heavy capital investment on platinum, which involves foreign exchange besides heavy recurring cost due to platinum loss, is avoided by employing the new process.

The total capital investment will be of the order of Rs 25 lakhs for a plant producing 120 tonnes of ammonium perchlorate/year. The cost of ammonium perchlorate per tonne will be about Rs 11 500.

The process received the Inventions Promotion Board's award of Rs 1000 (Independence Day Award, 1970). The inventors are Dr H. V. K. Udupa and Sarvashri S. Sampath, K. C. Narasimham, M. Nagalingam, C. J. Raju and P. Govinda Rao.



Electrode assembly in the cell for the single step preparation of perchlorates from sodium chloride

Microfilm Reader-cum-Xerographic Printer

A microfilm reader-cum-xerographic printer has been developed by Shri Mahinder Kumar Berman of the Indian National Scientific Documentation Centre, New Delhi. It is a compact machine comprising an arrangement for projecting the image of printed matter through a condenser on to a microfilm roll, and a lens to focus the image on a mirror; the mirror reflects the image on to a viewing screen for direct reading and subsequent printing. The novelty

of the machine lies in its capacity to reproduce prints on ordinary paper from both negative and positive 35 mm microfilm. It uses an indigenously developed electroscopic developing powder. It costs about Rs 15 000 whereas the imported counterpart costs Rs 1 50 000. The operating cost of the machine is only 25 paise per copy as against Rs 2.50 for the conventional photocopying system. The invention received a prize award of Rs 1000 of the Inventions Promotion Board (Independence Day Award, 1970).

aqueous solution but also for the study of non-aqueous electrolyte solutions. A reference to the literature indicates that studies on non-aqueous solutions are limited. In non-aqueous or mixed aqueous organic solvents of low dielectric constants ion pair formation can play an important role in changing the half-wave potential. The polarographic behaviour of some cations in non-aqueous and aquo-non-aqueous media forms the subject of investigation of a new CSIR research scheme granted to Dr C. M. Gupta (principal investigator) of the Department of Chemistry, Rajasthan University, Jaipur.

CSIR SUPPORT TO RESEARCH

New Schemes

Ultimate Strength of two-way Post-Tensioned Prestressed Concrete Slabs under Static Loading

Yield line theory for reinforced concrete slabs is now an accepted procedure all over the world. But the application of the theory to prestressed concrete slabs does not appear to have attracted the attention of research workers much. It is therefore proposed to study all aspects of the problem under a new CSIR research scheme sanctioned at the P.S.G. College of Technology, Coimbatore. Prof. T. S. Ramakrishnan, the principal investigator, proposes to study analytically and experimentally the behaviour of two-way concrete slabs with post-tensioned steel under point and line loads both in the elastic and plastic stages. The yield lines will be observed and analysed with a view to arriving at a possible yield criterion for their failure. Limits on deflection will be proposed keeping in view the effects of edge membrane forces also. The results are expected to lead to the formulation of a rational and economical design procedure for such slabs.

Relaxation Processes in Dielectrics

The object of this new CSIR scheme granted to Shri Pradip Kumar (principal investigator), Department of Physics, Allahabad University, Allahabad will be to study the relaxation processes in polar organic liquids at microwave region. The work will be first extended to those substances which have been found to show typical and interesting behaviour with change of temperature and concen-

tration. The study of hydrogen bonding properties, group rotation and molecular forces in the compounds will be of special interest. The effect of viscosity on the relaxation processes will also be investigated.

Behaviour of Concrete Flexural Members Reinforced with Indian Deformed Steels

Under a new CSIR research scheme sanctioned at the Indian Institute of Technology, Madras on the recommendation of the Civil Engineering and Hydraulics Research Committee, Dr Ing. P. Srinivasa Rao, the principal investigator, proposes (1) to critically examine the existing theories of crack formation in R. C. beams; (2) to develop methods to predict the crack widths at any steel stress level for the Indian deformed steels; (3) to estimate the crack widths and deflections that are likely to occur under present allowable stresses; and (4) to compare the behaviour under working loads of beams reinforced with different types of steel whereby the ultimate strength on the beam will be kept the same. It is also intended to extend the studies to cover the behaviour of these steels under dynamic loading conditions.

Reversible and Irreversible Processes at Dropping Mercury Electrode in Aqueous and Non-aqueous Media

The study of reversible and irreversible processes in aquo-non-aqueous media in polarography is engaging the attention of workers. Inorganic polarography in organic solvents is suited not only for the analysis of such inorganic substances as are precipitated or hydrolysed in

Buckling of Plates in Plastic and Strain Hardening Range

Use of wide flange I-Section beams in structural frames has a severe limitation in the application of plastic design on account of the occurrence of local (plate) buckling. The flanges should be able to sustain strains considerably larger than the yield strain without local buckling. Strain hardening tends to cause the flexural strength of a wide flange steel section to be higher than its fully plastic strength and instability tends to make it lower than the fully plastic strength. Little work has been done to study the local buckling of wide flange beams in flexure in the plastic and strain hardening range. Some empirical expressions have been worked out on the basis of a limited number of experiments in this field. In a new CSIR research scheme sanctioned at the Faculty of Engineering, University of Jodhpur, Jodhpur, the principal investigator Prof. S. C. Goyal proposes to carry out research on the post-elastic buckling of flanges of I-Section and its effect on the moment of resistance of plastic hinges.

Experiments will be conducted on built-up I-Section beams with different width-to-thickness ratios of the flanges. The web will be kept sufficiently thick so that no buckling takes place in the web. Some 40 beams will be tested to failure and strain will be determined using electrical resistance strain gauges. The beams will be annealed before the tests. It is also proposed to provide a rational basis on which the effective moment of resistance of

wide flange sections could be worked out for various width-to-thickness ratios of the flanges for continuous beams in multi-storeyed frames and other structures.

Effects of Reverberation on Concrete Properties

This is the title of a new CSIR research scheme granted under the purview of the Civil Engineering & Hydraulics Research Committee jointly to Shri N. N. Purandare (principal investigator) of N. N. Purandare Associates, Bombay and Prof. V.N. Gupchup of the Structural Engineering Department, Victoria Jubilee Technical Institute, Bombay. Extensive research will be carried out on the effects of revibration under Indian conditions on: (i) compressive strength as cube strength, (ii) tensile strength on tensile specimens and splitting of cylinders, (iii) shear strength as shear in beams, (iv) bond strength, (v) shrinkage in concrete as applicable to the shrinkage losses in prestressed concrete, and (vi) creep in concrete as applicable to prestressed concrete. It is also proposed to study the changes in the structure of cement paste after revibration at different intervals of time. The results are likely to reveal whether the increase in strength is of permanent nature or due to accelerated strength or due to early hardening of concrete.

Chlorination of Rock Phosphate and Solubilization without using Sulphuric Acid

On account of the shortage of sulphur efforts are being made to replace sulphuric acid by other chemicals in the production of soluble phosphates from rock phosphates. Two alternative methods which are in the experimental stage in India are: (i) fusion of felspar with rock phosphate; and (ii) reaction of urea nitrate with rock phosphates. In a new CSIR research scheme granted to Prof. V. Ramakrishna (principal investigator) of the Indian Institute of Technology, Delhi it is proposed to work out conditions for producing soluble phosphates from rock phosphate by chlorination. The conditions of chlorination such as temperature, chlorine pressure contact time, etc. will be studied to evolve a laboratory method which

will be scaled up for industrial application.

PATENTS FILED

126120 : A fluidized bed reactor for carrying out reactions involving solids and gases, K. Seshacharyulu, P. S. Murti, M. A. Sattar, G. C. Gopi Reddy, R. Vaidyeswaran, B. S. R. Sastry, R. N. Parlikar & K. S. R. Patil—RRL, Hyderabad.

127575 : A process for the manufacture of xanthotoxin (8-methoxypsoralen) from the roots of *Heracleum candicans*, K. L. Handa, P. R. Rao & R. K. Sahdev—RRL, Jammu.

127706 : A power trowel, J. P. Kaushish & B. Dass—CBRI, Roorkee.

127743 : A process for obtaining colchicine from a new plant source, V. H. Kapadia, Sukh Dev—(NCL, Poona) and R. S. Rao, Botanical Survey of India, Poona.

127748 : A process for making multiple prints of a document with an electrophotographic machine, P. C. Mahendru, D. C. Parashar, G. D. Sootha, D. Singh & N. Kumar—NPL, New Delhi.

128319 : Improvements in or relating to red dye penetrants for surface flaw detection, M. C. Narasimhan & J. Pal—CMERI, Durgapur.

128320 : Improvements in or relating to the preparation of ferric sulphate, T. P. Prasad, B. R. Sant & G. S. Chowdhury—RRL, Bhubaneswar.

Symposium on Pressure Vessel Technology

A symposium on Pressure Vessel Technology will be held at the Central Mechanical Engineering Research Institute, Durgapur during February 1971. The main topics of discussion at the symposium will be: Design analysis of pressure vessels, including high pressure vessels; Fabrication aspects of pressure vessels; Inspection and testing of pressure vessels; and Modern trends and future developments in the main aspects of pressure vessel technology. Further details regarding the symposium can be had from the Director, Central Mechanical Engineering Research Institute, Durgapur 9.

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

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Applications are invited for the post of Director in the scale of Rs 2000-100-2500 for the Central Salt & Marine Chemicals Research Institute (CSMRI), Bhavnagar.

The main objects of the institute are research and development for (i) the improvement of the salt industry; (ii) the utilization of byproducts from marine and inland lake bitters; and (iii) recovery, production and utilization of marine chemicals. The institute also carries out research on desalination of water, use of seawater for agriculture, and exploitation of seaweeds and algae as sources of food and chemicals.

Candidates should have high academic qualifications in a field of science/technology and should have to their credit outstanding research and/or development experience, and leadership in formulating and guiding research and development programmes in an area covered by the institute.

Job Requirements : To head the Central Salt & Marine Chemicals Research Institute, Bhavnagar and to plan, guide and conduct research and development programmes and projects of the laboratory.

There is no standard form of application. Those who wish to be considered are invited to send a statement of their qualifications and attainments with the following information to the Secretary, Council of Scientific & Industrial Research, Rafi Marg, New Delhi 1, on or before 7 December 1970: (1) name, (2) full postal address, (3) date and place of birth, (4) examinations passed and degrees and qualifications obtained with class or division year-wise, subjects taken and names of institutions and the universities, (5) countries visited, duration and purpose, (6) details of post-graduate work, with copies of list of publications with reprints, (7) details of how employed so far and (8) names and addresses of three referees.